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England's municipal waste regime: Challenges and prospects

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This paper provides a synthetic account of England's municipal waste regime at the end of the 2010s. In technical-material terms, the regime, previously heavily dependent upon landfill, is now characterised by energy-from-waste and recycling and/or composting in fairly equal measure. This infrastructural transformation, enacted over some 20 years, has been underpinned by the financialisation and marketisation of England's municipal waste. Residual waste has been constituted as a financial asset whilst both residual waste and materials collected for recycling are the basis for further commodity production. The corporate landscape is dominated by large, European-based transnationals. As well as documenting the regime and its emergence, the paper highlights, and accounts for, the multiple challenges it now faces – chiefly, the technical failure of residual waste solutions which necessitate a continued reliance on landfill for some councils, the collapse of the export markets on which England's resource recovery has depended, and a radically changed policy landscape that seeks to move England towards a more circular economy. We suggest that local authorities' waste infrastructure, procured in response to a linear economy, threatens and is threatened by these new policy directions.

KEYWORDS
circular economy, energy-from-waste, infrastructure, municipal waste, recycling, waste regimes

1 | INTRODUCTION

At a 2014 Historical Witness Seminar on waste management in the UK 1960–2000, an expert witness recounted seeing a spate of visitors from Eastern Europe in the 1970s (Jones & Tansey, 2015). Identifying parallels between the UK and Eastern Europe, the visitors were keen to learn from what they termed "*the* truck and dump country of Europe." By the late 1990s that "truck and dump" country was facing major challenges. Membership of the EU required the UK to move away from a municipal waste regime which had been heavily dependent on landfill since the 1920s (Cooper, 2010).

In response to concerns about methane's contributions to greenhouse gas emissions, 1990s European environmental policy identified landfill as the least desirable of waste management options. That was cemented in a key heuristic: the waste hierarchy, in which landfill occupied the bottom tier of technical solutions for managing waste. Above it a range of options sought, at best, to minimise and/or prevent waste, and then to recover materials for recycling. Ranked below these options was recovering materials for energy (energy-from-waste, or incineration), and below that, incineration without energy recovery – with both options still preferred to landfill. The waste hierarchy dominated European waste management thinking and waste policy for 20 years. Its effect is impossible to overstate, especially for member states dependent on the deemed obsolete technology of landfill. In the face of severe financial penalties for non-compliance, a root and branch transformation of municipal waste infrastructure was required. Nothing short of a new municipal waste regime had to emerge.

The process of transforming the UK's municipal waste infrastructure began in the mid-late 1990s. It has entailed policy formation at multiple intersecting scales (national, local, and sub-regional) with infrastructure provided via public–private partnerships involving local authorities (LAs) and the market, comprising waste management firms and finance capital. That has occurred within a planning context where siting controversies, particularly opposition to energy-from-waste proposals, have been the norm. In the light of those controversies, as well as construction and technological challenges, and fall-out from the 2008 financial crisis (specifically, the loss of financial backers, banks' reluctance to lend on "riskier" technologies, and the effects of austerity measures on local government finances), it has taken many years to see facilities on the ground. However, it is now possible to distil what has emerged at the national level. The overall intent of the paper is to identify (1) the broad contours of the municipal waste regime that has emerged over the past 20 years in England, (2) the challenges encountered in its emergence, and (3) those now faced. Chief of these is that a municipal waste infrastructure designed in response to the policy framework of the late 1990s and early 2000s, and which assumed a linear (take-make-dispose) economy, is now confronted by a new set of policy challenges that push in the direction of a more circular economy.

The paper has three main sections. Section 2 situates the paper, highlighting its contribution to the wider field of critical waste studies, inflected through the concerns of economic geography. It establishes why it matters to think about municipal waste through municipal waste regimes, and how that relates to the wider concept of a waste regime as developed by Gille (2007). It also details the data used in the paper. Section 3 examines the municipal waste regime that has emerged in England since the 1990s. It establishes the broad contours of the regime in technical-material terms before presenting a set of arguments about this regime that are located in a synthetic interpretation of our data. In Section 3.1 we examine the persistence of landfill as a disposal option. Working with the political, economic, and material dynamics that Gille identifies as critical to any waste regime, we connect landfill's persistence to the failure of planned residual waste infrastructure. In Section 3.2 we turn to the resource recovery part of the regime. Again, we draw on the interplay of political, economic, and material dynamics to suggest the suite of challenges now faced. In Section 4 we conclude by considering the challenges faced by the regime as a whole as, in the light of England's 2018 Waste Strategy, waste is increasingly recast as a resource.

2 | METHOD

To make reference to a municipal waste regime begs the question of how that relates to Gille's influential concept of the waste regime (Gille, 2007). Gille is one of a number of figures in waste scholarship to have pushed that field away from the identification of waste with (end-of-pipe, post-consumer) municipal waste toward the myriad activities from which waste emerges. Her concept of waste regimes anchors that move. By this she means the economic, political, and material dynamics through which waste is produced at the societal level. Working in the Hungarian context, she documents a transformation from a metallic waste regime, founded in salvageable scrap metal and recycling infrastructure, to a chemical waste regime, in which the predominantly toxic by-products and residues of the chemical industry are varyingly stored, dumped, or incinerated, at huge environmental cost. An almost inevitable effect of expanding the compass to the societal level, however, is that municipal waste becomes side-lined.

At first sight that side-lining is consistent with the idea of a waste regime. Although they generate waste, municipalities are not the producers of the wastes they have the political responsibility for managing – the material discarded by the households and businesses located within their geographical boundaries. In that sense, to understand municipal waste there is a need to look inside households, and that is where attention turned (Bulkeley & Gregson, 2009; Evans, 2014; Watson & Meah, 2012). However, that is to overlook that municipalities shape the materiality of municipal waste (Bulkeley et al., 2007; Davies, 2008). For, along with the political responsibility for managing municipal waste, is the responsibility for procuring an infrastructure for managing discarded materials.

Municipal waste infrastructure comprises various receptacles (bins, boxes, containers) for the temporary storage and collection of categories of materials from households and businesses, for example, recycling, food waste, residual waste, green waste (Chappells & Shove, 1999; Metcalfe et al., 2012). It also includes fleets of collection vehicles, waste transfer stations (where materials collected are sorted and bulked for onward transportation), materials recovery facilities (MRFs, which attend to material captured for recovery for recycling), plus varied technologies that attend to residual waste – energy-from-waste plants, MBT (mechanical/biological treatment) plants, as well as landfills. What that waste infrastructure is, the precise combination of technologies and processes assembled in, and available to, a municipality, matters. The infrastructure has a profound effect on the wastes that any municipality generates. Further, the waste infrastructure which municipalities collectively put in place to manage discarded material plays a substantial role in determining the material dynamic of waste

at a societal level. Municipalities, then, are key agents in the constitution of particular waste regimes – which is not to say that waste regimes are to be reduced (once again) to municipal waste, but rather that it is helpful to think of municipal waste regimes, as a subset of the wider whole, and to address the economic, political, and material dynamics through which waste is produced at this scale.

How can those dynamics be captured? What methods allow for their identification? In line with broader tendencies across the social sciences, waste scholarship in the social sciences, and most especially critical waste scholarship, has tended to default to the in-depth case study, typically conducted through a suite of qualitative methods – for the most part interviews but also ethnography, participatory, and action research. Although hugely insightful, this work cannot document the contours of a municipal waste regime. To do that requires working with national level data, disaggregated to the level of municipalities, and to find ways of attending to the economic, political, and material dynamics of municipal waste across multiple municipalities. To that end, the paper presents findings and interpretations integrated from three sets of data.

First, there is WasteDataFlow (HM Government, 2018). This is a government dataset, released by the Department for Environment, Food and Rural Affairs (Defra), based on data reported annually by municipalities with waste collection and disposal responsibilities. The data record the weight and percentage of material that is collected for recycling (and composting) and for incineration (via energy-from-waste, and otherwise), and that is landfilled. In accordance with policy targets, WasteDataFlow records diversion from landfill figures and recycling rates, and is the basis for annual performance tables. Changes to methods of recording make year-on-year comparisons unreliable. In the paper therefore we work with 2017/18 data (the latest available at the time of the research) to provide the technical-material contours of England's municipal waste regime.

To capture economic and political dynamics we have assembled two further bodies of data. The first is a dataset of waste management contracts current in the UK (as of 31 March 2019). It itemises 1,604 contracts (Forman & Gregson, 2021). The dataset was derived by searching national and regional procurement portals for details of waste management contracts (Proactis, gov.uk), searching council websites and news reports for information on contracts held by specific councils, and finally – where information was not publicly available – by submitting FOI requests. Further details on the dataset, its construction and analysis are available in Appendix S1.

For our purposes the dataset has been reduced to exclude the devolved administrations of Wales, Scotland, and Northern Ireland which have responsibility for waste. To allow for a tighter analysis of contracts pertaining directly to waste infrastructure, the dataset was refined further to exclude contracts pertaining to: legal and technical advice/services, waste management IT systems, the purchase and provision of collection infrastructure, that is, supply of refuse vehicles, containers, bins and bags, skips; specialist hazardous waste, which must either be incinerated or land-filled (e.g., clinical waste, asbestos, hazardous chemicals); confidential waste services (e.g., shredding); contracts relating to dog faeces and stand-alone contracts relating to street cleansing.[1] To eliminate a considerable number of short contracts for services of low value, it was also limited to contracts with a known estimated total value of more than £1m.[2] The subset that forms the basis of the analysis and interpretation in the paper has over 700 contracts, spread across the 348 municipalities in England.

The second body of data is an archive of minutes, papers, and reports available online via LA websites pertaining to waste management for 125, or roughly 40%, of England's municipalities with responsibility for waste disposal and/or collection.[3] The archive was constituted through a purposive sample. It includes councils from a majority of the English standard regions (specifically, the North East, North West, East Midlands, South East, and South West), multiple large northern metropolitan councils (including Greater Manchester, Merseyside, Leeds, Sheffield), Inner and Outer London Boroughs, as well as smaller cities in the East Midlands, South East and South West, and some of the shire counties. It includes multiple examples of municipalities with contracts with the major firms in the UK waste market (Veolia and Suez), many instances of contracts with other key firms in the sector (e.g., Viridor, Shanks, Biffa, FCC, Amey) and single instances involving new market entrants. It also includes multiple examples of the major residual waste technologies (energy-from-waste and MBT) to have been procured in England, including 17 funded through PFI (Private Finance Initiative) mechanisms.

3 | RESULTS AND DISCUSSION

The contracts dataset highlights the corporate transformation that has occurred in England. A landscape that in the early 1990s was characterised by small, often locally or regionally based firms focused on landfill and associated haulage activities is now dominated by large, mostly French- and Spanish-owned transnationals specialising in environmental services, and major UK outsourcing firms and conglomerates. The transformation is an indication of the size of the UK's municipal waste market, particularly England's. The privatisation of England's municipal waste in the 1990s opened up a major new market for continental European waste management firms. Municipal waste was also identified as an attractive area of

business expansion by UK outsourcing companies and by firms in allied industries, notably those specialising in water and utilities.

Market domination in the UK's municipal waste sector is suggested by Statista, who highlight that "the Big Five" firms in UK waste management (Veolia, Suez, Viridor, Biffa, and FCC) generated revenues of £4.8bn in 2017/18, exceeding the combined revenues of the next 15 firms (Statista, 2018). It is further confirmed by Table 1, which ranks the main suppliers of waste/resource recovery services to LAs in England by the estimated annual value (£) of their contracts.

Table 1 also suggests that, at least in terms of percentage share of total contract value, "the Big Five" is more a Big Two. Veolia and Suez's contracts combined account for 31% of the estimated total value of England's waste/resource recovery market (~£86bn) and 28% of the estimated annual value (~£4bn). In other words, two French-owned transnationals (possibly soon to be one) have succeeded in capturing the largest share of the value in England's privatised municipal waste market.[4]

Further scrutiny shows the degree of lock-in in this landscape, particularly with respect to residual waste (cf., Behrsin & de Rosa, 2020; Corvellec et al., 2013). Long duration contracts (25–30 years) are the norm. As important is that those long contracts signal the presence of a model of infrastructural financialisation that is becoming increasingly widely recognised in the economic geography literature (Allen & Pryke, 2013; Loftus & March, 2016; Pryke & Allen, 2019). Just as other facets of key infrastructure such as water, roads, bridges, and airports have been financialised, so too has England's residual waste. Although beyond the scope of this paper, the broad details are this: LAs' modelling projections of household discard as a function of population and household growth, alongside material characterisations of that discard, informed their procurement of residual waste management facilities, specifically the size, scope, and technical specifications of plant agreed with their preferred bidder. The residual waste contracts signed by LAs and their preferred bidder formalised the delivery by LAs, over multiple decades, of guaranteed tonnages of discard, to satisfy particular material characterisation thresholds. In turn, those contracts are underpinned by a financial payment made by LAs to their supplier/s for the services delivered (the annual charge). Those guaranteed payments, spread across decades, and the guaranteed flows of discard on which they depend, have allowed for England's residual waste to be turned into a financial asset, typically through the formation of special purchase vehicles (SPVs).

Alongside that economic transformation has been a technological change of equal magnitude. Table 2 utilises data from WasteDataFlow to provide a snapshot.

The table shows that energy-from-waste (incineration) and recycled/composted now comprise the two primary categories for managing England's municipal waste. They are the destination for 43% and 42% of total waste, respectively. That pattern suggests that the policy drivers that were put in place to effect diversion from landfill have done their job. This we do not dispute. To focus on the headline pattern, however, is to miss two finer nuances.

The first is the total percentage of municipal waste destined for landfill in 2017/18 (13%) and the regional variation in that percentage figure (8–22%). By EU standards, those percentages are well in excess of what is desired. They also raise questions over the degree to which England has been able to break with its past and appear suggestive of legacy effects.

TABLE 1 England's contracted waste/resource recovery market, by supplier (ranked by % estimated annual contract value [£]).

	Estimated total value (£bn)	Estimated annual value (£m)	% of grand total contract value	% of annual grand total contract value
Veolia	11.6	574	13.6	15.2
Suez	15.1	499	17.7	13.2
Viridor	5.4	198	6.3	5.2
Biffa	2.4	161	2.8	4.2
Renewi/Shanks	5.7	149	6.7	3.9
Amey	6.1	136	7.1	3.6
Kier	1.6	114	1.9	3.0
Serco	1.5	103	1.7	2.7
FCC	1.3	82	1.5	2.2
Estimated grand total contract value	85	3,780		

TABLE 2 Management of local authority collected waste in England's regions (ranked by % landfill): 2017/18.

Region	% Landfill	% incineration with efw	% Recycled/composted
South West	22	27	49
North West	19	30	45
East Midlands	16	37	44
Eastern	12	35	48
Yorks & Humberside	10	44	42
London	10	56	30
South East	9	43	47
North East	8	54	37
West Midlands	8	52	39
Total England	13	41	42

Note. Percentages do not sum to 100 as the table excludes small amounts incinerated without energy-from-waste (efw) and categorised as other.
Source: Defra, WasteDataFlow.

This is not the case. As we argue in Section 3.1, drawing on the archive data, political, economic, and material dynamics, the central components of the waste regime concept, can help account for landfill's persistence as a waste management technology – showing even the necessity for its persistence.

The second is that the percentage of material captured for recycling in England (42%) is distinctly average in terms of the wider UK and in relation to European norms and expectations, and certainly well below the 2020 target of 50%. That figure indicates the political failure of recycling in England and flags the troubled state of the resource recovery element of England's municipal waste regime. In Section 3.2, we weave together a combination of political, economic, and material dynamics to account for these difficulties.

3.1 | Accounting for the persistence of landfill – a story of planned infrastructure failure

In charting landfill's persistence within England's municipal waste regime, we begin with the political dynamic. National waste policy formulated in the early 2000s in England made no technological assumptions regarding how municipal waste was to be diverted from landfill, and how EU targets were to be met, delegating that decision to local government. Nonetheless, technological neutrality was accompanied by premises and presumptions that, singly and collectively, exerted influence on LA decision-taking.

Chief of these was a strong commitment to the role of the private sector in delivering the UK's municipal waste infrastructure and waste management services. This was formalised most clearly in the availability of PFI funding to aid the financing of municipal waste infrastructure. With the benefit of hindsight, three further premises and presumptions proved significant. They were: first, the assumed-to-be-widespread public opposition to energy-from-waste (incineration) as a technology, which was sufficient to dissuade the government of the time from pursuing an incineration-led waste strategy and which lay behind the technological neutrality of national policy; second, a strong commitment to exploring the potential in new waste management technologies, particularly MBT[5] that itself was in line with UK government's wider commitments to technological innovation, and an endeavour to boost competition in the UK waste market;[6] and third, a clear steer towards maximising the amount of discard captured for recycling. As LAs began to formulate their waste strategies, these became central tenets for municipalities seeking to position themselves as leaders in waste management – as will become clear, with effects.

To get to this position, there is a need to back track, specifically to the modelling of municipal waste flows, and supporting technical work, that informed the development of local waste strategies and policy formation in the early to mid-2000s. Modelling work signalled consistently that LAs could not meet their landfill diversion targets through recycling alone. Whilst waste composition analyses, which provided a characterisation of the existing municipal waste stream, showed that more material, especially paper, card, and glass, could be captured for recycling, projections of waste/household and of population growth showed incontrovertibly that LAs required long-term technical solutions for large volumes of "residual waste" – or material deemed not suitable for recovery for recycling. That is the point at which LAs, and particularly waste disposal authorities who have the responsibility for managing residual waste, faced head on the presumption of opposition to incineration in their own back yards. In local government, then, there was recognition, anticipation even, that any such opposition

would certainly delay any such proposed facilities, but more than that, might well succeed in overturning local waste plans. To travel this pathway could be anticipated to entail not only serious political risks (in the worst case, a failure of local policy, with attendant loss of political capital for incumbent administrations) but also result in a major financial burden, in the shape of a continued need for landfill solutions for large volumes of residual waste. The response to that anticipated political reality across England's LAs was broadly three-fold. Whilst some LAs went into procurement for waste management services with a commitment to securing an energy-from-waste solution, others started from a position of technological neutrality, leaving it to the technical evaluation of bids to establish the best value-for-money option for local taxpayers. A third set of LAs opted to go into procurement explicitly seeking a non-energy-from-waste solution.

These political decisions also had an economic dynamic. To opt for energy-from-waste was to go with the mature, "bankable" technology in the waste sector, notwithstanding the planning risk. It was (and remains) the industry's preferred, known technology and it is the residual waste technology of choice for the lead firms in the sector – the two French transnationals, Veolia and Suez. In terms of the political-economic dynamic of an emergent waste regime, for LAs taking this route, economic considerations outweighed the political risks. Energy-from-waste was seen to be the least risky means to avoiding large bills for landfill. By contrast, to reject energy-from-waste from the outset was to go not only with innovative, either unproven or not at scale, waste management technologies but also, frequently, with new market entrants – be these established firms entering the waste market, new consortia, or new firms.[7] In these circumstances, the political risk of opposition to energy-from-waste was deemed to trump the economic risks of the new technologies/new firms' route. But there was also a degree of symbolic capital at stake too, for innovative technologies, particularly those that promised to deliver strongly on recycling performance, proved highly attractive to LAs with aspirations to establish themselves at the forefront of municipal waste management in England.

By the mid-late 2000s, with most LAs in varying stages of procurement for waste management services, it was clear that no single municipal waste regime was emerging in England. Instead, two alternatives, with different technical-material implications were in varying throes of materialisation. On the one hand, there was a tranche of energy-from-waste plants. In material terms, they were to turn residual waste to electricity, and – very occasionally – to heat, to power district heat networks. On the other hand, there was an enhanced materials recovery regime. Attracted by the claims made with respect to MBT, a significant minority of LAs and/or waste partnerships (29) had entered into partnerships with consortia (mostly comprising new market entrants) that promised enhanced capture of recyclable material from the residual waste stream,[8] the turning of the organic fraction of residual waste (chiefly food waste) to a compost-like material (CLO), and the production of a fuel from the remaining residual fraction (SRF [Solid Recovered Fuel] or RDF [refuse-derived fuel], depending on the technology used). This was a clear attempt to do something different to the industry standard and a departure from EU norms. However, and in ways that would turn out to be critical, unlike electricity generated from energy-from-waste plants, which qualified as a form of renewable electricity (Behrsin, 2019), neither CLO nor RDF had guaranteed markets. Indeed, in the case of CLO, there was not even a guarantee that it would escape its waste label and be qualified as a marketable good.

Some 10 years on, that planned materialisation is – for the most part – on the ground, at least as plants, but it has not been plain sailing. As anticipated, the opposition to energy-from-waste was intense (Rootes, 2006; Rootes & Leonard, 2010). It led, at minimum, to widespread delays in planning – many of the order of well over five years, several of around eight years and – in extreme circumstances – to the termination of contractual agreements. Those delays were compounded in some circumstances by the effects of the financial crisis on corporate financing and they left many LAs requiring interim solutions for their residual waste. Whereas some secured interim contracts with neighbouring authorities with spare incinerator capacity, others have had to resort to interim landfill contracts. So, the failure to secure planned energy-from-waste solutions is one reason why England continues to send higher than anticipated volumes of material to landfill. The other, however, is the widespread failure and/or sub-optimal performance of the enhanced materials recovery regime.

Look across the LAs and waste partnerships that sought to procure an enhanced materials recovery regime and their experiences constitute a catalogue of failure. Three types of failure stand out. First, there is economic failure, as firms (invariably new market entrants) either went into administration or decided to exit the waste market, leaving consortia, at best, without key suppliers or, at worst, minus a major consortium partner. Whilst the best-case solutions to this problem involved bringing in new suppliers, with inevitable delays, contract renegotiations and new financing, in the worst cases, LAs have been left with sub-optimal assets that are unattractive propositions for other firms in the sector, and requiring another disposal option for the waste that was planned to be processed by these plants. Second, there is technological failure. Several plants, once constructed, have struggled to pass the qualification trials set for "hot testing," meaning – at best – they cannot work anywhere near designed operational capacities – and, at worst, that they have yet to actually work at all. Then, when plants have passed qualification trials, several have been shut down by the Environment Agency (often for months at a time) – typically due to odour control issues. That has required expensive technical solutions to remedy and

interim solutions for the waste that can no longer be processed. Other plants, meanwhile, although operational, have failed to achieve the performance levels suggested during procurement. This has affected aspirations, as plants that promised to deliver an additional 10% plus to a LA's recycling rate, through extracting value from the residual waste stream, struggle to achieve 2% recovery rates. Third, and perhaps most critically, there is the market failure of materials, particularly the CLO derived from MBT plants. After much controversy, Defra declared in a 2012 Technical Brief that:

> CLO or digestate from mixed waste processing [the residual waste stream] will not qualify for BSI PAS 100 or PAS 110 [the technical standards an organic material derived from waste must reach if it is to qualify as a secondary product] – and it is unlikely to be applicable for inclusion in recycling rates/targets. (quoted in Tolvik Consulting, 2017, p. 11)

Without an outlet, large volumes of material have required, and continue to require, alternative disposal solutions – usually landfill.

Returning to Table 1, regions with a higher percentage of municipal waste heading to landfill include many LAs that embraced the potential in an enhanced materials recovery regime, aspired to be "world leading," and procured solutions designed to divert residual waste from landfill by converting the organic fraction to compost. With no other disposal outlet for the organic fraction derived from their residual waste stream, landfill is the destination of last resort. Landfill's persistence as a small part of England's municipal waste regime is a situation borne of necessity and a marker of the partial failure of its residual waste infrastructure – be that the political failure to deliver energy-from-waste solutions or the technological/economic failure of enhanced materials recovery solutions.

3.2 | The political, economic, and material challenges facing resource recovery in England

In contrast to residual waste infrastructure, procurement for the collection and processing of material suitable for recycling attracted less controversy. Once on the ground it initially performed as expected, lifting England's recycling rate from very low levels to 25%–30%. By the 2010s, however, England's recycling infrastructure was featuring in Judicial Reviews and a number of Select Committee inquiries. As with residual waste, thinking through the conjuncture of political, technical-material, and economic dynamics helps to illuminate the concerns. It allows us to suggest three core challenges currently facing the resource recovery component of England's municipal waste regime.

The first is political – the failure to reach EU and national recycling targets. Whilst England managed (just) to achieve the 45% recycling target required in 2015, the flat-lining of recycling figures was already causing concern, not least since 2020 pushed the target out to 50%. Figure 1 shows that these concerns were well placed. Whilst some LAs have managed to achieve recycling rates greater than 50%, the vast majority have not, with many still returning rates of 30%–40%, and 84 LAs (24%) returning rates of less than 35%.

The second challenge is a political-economic-material one. As inquiries proceeded, it became increasingly apparent that the infrastructure that LAs had procured for resource recovery was primarily processing material for export and that that material was mostly heading in the direction of China, then the largest global importer of material destined for secondary processing (Minter, 2015).

The third challenge is a political-economic-material one – that of plastic, specifically the exclusion of much of it from England's resource recovery activities. Initially that absence posed local-scale challenges, as environmental activists pushed councils on plastic's exclusion from recycling collections. More recently, in the wake of the widespread publicity afforded to plastic waste in UK media (e.g., Blue Planet 2, Hugh's War on Waste), the challenge has come home to bite in the form of classic environmental justice exposés that have shown plastic identifiable with English councils dumped in rural Malaysia (BBC – 20 September 2019).

All three of these challenges are rooted in the infrastructure procured for resource recovery in England. We discuss each in more depth in turn.

The political challenge of recycling rate targets

Simpler to build, requiring less financing, and less controversial, England's recycling infrastructure was "on the ground" ahead of residual waste infrastructure. Most LAs had it in place by the end of the 2000s. That has had effects. Building on the results from LA's waste composition analyses conducted in the early 2000s, resource recovery facilities (MRFs) were designed and configured to chase "easy tonnage," in other words materials that were sufficiently weighty and present in

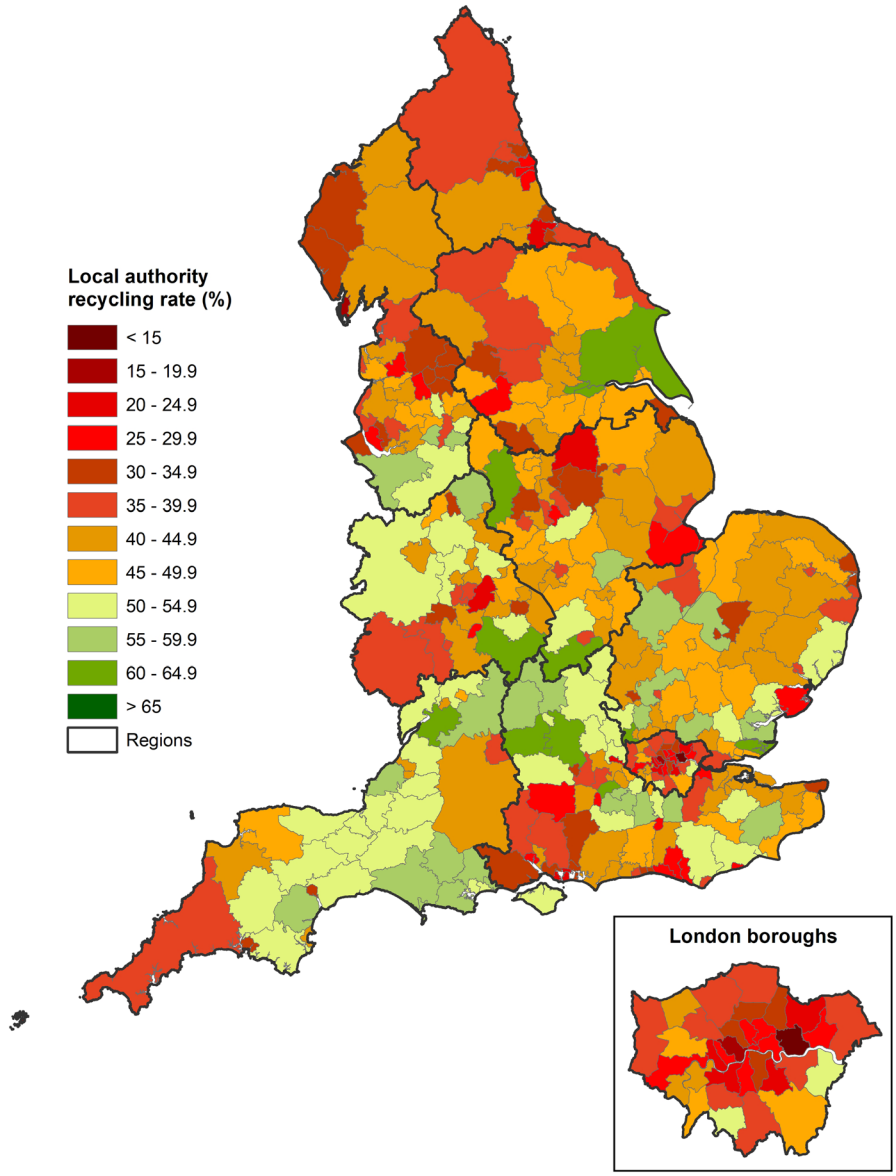

FIGURE 1 Recycling rates for England's LAs, 2017/18 (House of Commons Housing, Communities and Local Government Committee, 2019, p. 31).

sufficient volume in household discard to make a tangible contribution to diversion from landfill targets, that were relatively easy for mechanical technology to separate out, and for which there were clear markets. In practice that meant that most LAs settled on a core set of materials for collection (paper, card, and glass) whilst the MRFs sorted these (often) "comingled" collections into separate material fractions – critically, not into the finely differentiated grades of recovered material that attract higher prices in the secondary commodity markets. In other words, England's resource recovery infrastructure was designed and built to generate high volumes of low grade material that were only suited to the export markets of the time (Gregson et al., 2015).

The political challenge facing this infrastructure became clear relatively early. By themselves, MRFs were not going to achieve the progressively stepped recycling targets set by the EU. In response, compost (but not that derived from the residual waste stream) was included by Defra in the UK's recycling calculation and LAs began to add infrastructure targeting additional weighty materials, notably garden waste, effectively chasing tonnage to boost their recycling rates. Latterly, a minority of LAs have added separate food waste collection systems to their recycling services portfolio.

LAs with all these collection systems are able to meet the 50% recycling target and are held up as exemplars of good practice. Correspondingly, in the desire to achieve that target nationally, recent government policy has made it mandatory for food waste collection systems to be in place in England, by 2023. At the same time, councils whose recycling rates fall

under 30% have been subjected to considerable ministerial challenge and scrutiny, and clearly marked out as under-performing. The vast majority of these LAs cover dense urban/inner city areas. Penalised by patterns of living that make garden waste collection systems irrelevant, and food waste collection more challenging, their chances of realising recycling KPIs of 50% are slim. Further, in the face of intense budgetary pressures brought about by years of austerity, many such LAs face hard political choices. Relativities in core service provision are now being openly articulated. Faced with the political capital attached to other areas of core budget, notably social care and education, recycling services are under pressure and emerging as distinctly second-tier concerns for some councils. What that is opening up is a highly differentiated and increasingly polarising political landscape around recycling, one in which at one end there are "leafy, suburban and shire" councils where recycling rates are comfortably in excess of 50%, and – at the other – those "inner city, urban," more deprived areas where services are in the throes of being pared back to the statutory minimum, with recycling rates well below the levels that are deemed politically acceptable by national government.

The political-economic-material challenge of recycling infrastructure's output

On top of the political challenge of recycling rates is the political-economic-material problem posed by the output generated by England's recycling infrastructure. The chief catalyst here is the collapse of the export market consequent upon the China Ban (Gregson & Crang, 2019). Whilst there has been a degree of "market adjustment," demand by and large has not improved. Commodity prices remain low and MRFs have stringently applied their contamination acceptance criteria in an effort to uplift the quality of their output to a level that the market will accept. The outcome for many LAs has been a loss of revenue share from commodity sales, meaning that recycling services have become a cost rather than revenue generating stream, whilst most have experienced a major uplift in the rejection rates of their collections. Contamination levels have also led to recycling antagonisms in localities, with increasing pressure being applied to poorly performing neighbourhoods through invocations (and in some instances, enforcement measures) that emphasise the imperative to "bin it right."

Underlying that is an even more fundamental issue. Collapsing commodity prices and challenges over contamination have combined to render re-procuring recycling services more challenging. This is especially so for LAs where the industry deems the estimated "yield" from their areas to be poor and costs of collection high (read inner city, high density urban). Lack of market interest means that the option and/or necessity of bringing recycling collection services back "in house" is very much on the agenda. By contrast, and unsurprisingly, the private sector continues to bid for the dry recycling harvest of England's shires and suburban areas. We might suggest then that the polarities shown in England's recycling rates are increasingly hardening into a landscape of two-tier service provision, where the limits of a 30-year experiment in the privatisation of a public sector service have been reached.

The political-economic-material challenge of plastic

The final challenge facing the resource recovery component of England's municipal waste regime is plastic and the political push, inspired by environmental justice campaigns, to recycle more of it. Again, this is a political-economic-material challenge. The nub of the issue is three-fold: the lack of markets for many of the polymers that are propelled into household discard as a result of their widespread use in packaging and distribution; the technical challenges (and costs) of increasing plastics separation in MRFs; and an incineration infrastructure, for whom plastic is an important component of the feedstock.

Whereas markets for recovered HDPE (High-density polyethylene) and recovered PET (Polyethylene terephthalate) have ensured that most, but not all, of England's municipalities include these materials in their dry recyclable collection services, the lack of markets for the polymers comprising recovered films and wrappers, for example, or polystyrene packaging, means that they are deemed non-recyclable and thus pushed in the direction of the residual waste stream. Those (few) municipalities that currently do not collect HDPE and PET mostly procured their recycling services in the late 1990s. Their situations highlight that MRF infrastructure is a trade-off at the time of procurement between the policy goal of recycling rates and the economics of materials capture. Plastic's inherent lightness was (and remains) a distinct disadvantage here. It does not add much to the bottom line weight of materials sent for recycling, and hence to the calculation of recycling rates, so the political worth of its capture for municipalities (at least early on) was limited, certainly when compared to the easy gains of paper and glass.

With the politicisation of plastic waste, the clamour for enhanced collection has become considerable. However, adding new materials into infrastructure that is already operational is challenging. Retro-fitting is not only costly but also technologically and spatially difficult, in that it may not fit within the physical configuration of a plant and/or pose problems for the smooth operation of existing technology. So, the tendency to inertia, or infrastructural obduracy, is strong, with knock-

on effects for councils, who remain locked-in to the collection/processing configurations that were economic at the time of procurement.

As significant is plastic's worth as an incineration feedstock. Lacking the physical weight to be worth its capture politically, plastic became an important component of the residual municipal waste stream and therefore part of the calculation of the calorific value of the residual waste that a municipality would guarantee to supply to the residual waste facilities commissioned, notably energy-from-waste facilities. In turn, that calculation underpinned the technical design of the plant/s commissioned, whilst the calculations were translated into contractual obligations.

To increase plastic capture, then, requires not only that the technical challenges of recovering hard-to-recycle polymers be solved and markets for these materials be found, but also their diversion to resource recovery. The business economics of such a shift are to say the least uncertain, for published company accounts suggest that it is residual waste that is the most profitable sector of activity for the waste industry, not resource recovery. As significant is that such a shift would entail unravelling the material/technical and financial base that underpins the contractual relation between municipalities and their residual waste service providers. It would threaten to upturn the basis on which England's municipal waste has been economised and financialised.

4 | CONCLUSION

This paper has used official quantitative data, a contracts dataset, and an archive composed of publicly available minutes and reports to detail and interpret the transformation of England's municipal waste regime over the past 20 years. With respect to residual waste, England's municipal waste regime is inconsistent and difficult to name. On the one hand, there are arrangements supplied by the lead European firms in the sector which accord with the industry standard, and which replicate those found in the major cities of many northern EU member states. This is a regime characterised by high levels of incineration allied with electricity generation, but mostly minus the district heating networks that are a feature of many parts of northern continental Europe. On the other, there is a landscape of experimentation, and largely failure, associated primarily with up-scaled and/or innovative waste management technologies and new market entrants, many of whom have now exited the waste market. It promised, but failed to deliver, enhanced levels of resource recovery on top of processing residual waste. Layered over this is the resource recovery part of the regime. It has failed to meet the targets set for recycling; it mostly separates materials into relatively few, often fairly contaminated, categories and grades, which have relied on export markets that now no longer accept such materials; and, for the most part, it is unable to address the challenge of plastic waste.

This is a municipal waste regime in more than a degree of difficulty. The challenges, however, go further than the partial failure of infrastructural provision and an accompanying landscape of stranded, or at the very least, sub-optimal assets. In late 2018, a new national Waste Strategy for England was introduced – the first major policy intervention in the field for 20 years. It recast waste as a resource and set England on a road towards a fuller enactment of circular economy principles, in which enhanced resource recovery and extended producer responsibility sit centre stage alongside the reduction and minimisation of waste. The changed policy context means that an infrastructure put in place to address waste generated by a linear economy is now tasked with a very different brief. By way of conclusion, we itemise and discuss some of the high level challenges to England's municipal waste regime posed by the new policy context, and highlight the difficulties that the regime itself poses to the fulfilment of the new policy objectives.

The marketisation of England's municipal waste from the 1990s onwards translated household discard into both a financial asset and the commodity form. There is then a fundamental tension at the heart of the current regime – between waste's capacity, in and of itself, to realise financial value and its capacity, through further processing and/or treatment to realise materials or outputs that are the basis for further value extraction through commodity production. In the current regime that tension resolves in favour of the generation of financial value. On the ground, and in technical-material terms, the primary purpose of the regime is to generate contracted levels of residual waste – for this is what finance capital not only wants but also depends on for the large waste management transnationals and conglomerates to service their debt and for waste management infrastructure to generate shareholder value. That is further reinforced by the pressures facing the recycling sector, where current contamination levels and the attendant lack of markets for much recovered material mean that the value being extracted from the dry recyclable fraction of the municipal waste stream is currently in steep decline. This situation, however, is the converse of what is desired and enshrined in circular economy goals, where landfill is anathema, where residual waste is to be reduced markedly, and where resource recovery for recycling sits at the fulcrum, as the most valued activity, since it turns waste to resource. We suggest then that the underpinning economic configuration of England's municipal waste regime will be a block to the enactment of the new policy.

At the same time, the resource recovery element of the regime is potentially further threatened by these same policy goals. As the lead firms in the sector push to develop market share in "closed loop" recycling infrastructure and build business alliances with partners that enable them to capture dry recyclables outside the municipal waste stream – be that through "on the go" recycling or direct return schemes – the direction of travel in resource recovery is becoming clearer. The consequences for the dry recyclable fraction of the municipal waste stream bear stating: in the face of these more homogenous, and hence cleaner, collection streams, co-mingled, dry recyclables will be the material that no one really wants. Yet LAs, given their statutory responsibilities, will continue to need to collect dry recyclables, as efficiently as possible – which means mixed, and hence more contaminated material. With no market for this material, it is difficult to see any other destination for it than the residual waste stream. Such a situation only threatens to intensify what is already "hot" politics in relation to household participation in recycling.

For well over 100 years in England, municipalities have been the intervention point of last resort in waste management, epitomising their end-of-pipe positioning in the linear (take-make-dispose) economy. The infrastructure that is now in place in England is the materialisation of LAs' statutory responsibility to collect and/or dispose of the wastes generated by household consumption and local businesses, and to do so in ways that align with the European environmental policy of the 1990s. With circular economy thinking increasingly prominent in policy, an increasingly urgent challenge is to recognise the implications, specifically for a waste management infrastructure that has been economised assuming the generation of waste by the linear economy, and for the LAs whose capital assets this infrastructure is. To this end, perhaps the best starting place is with the most fundamental of questions, namely, what, in an era of heightened producer responsibility for resource recovery, is the role of the municipality, and what, in turn, are the possibilities, as well as the limits, in such an arrangement for bodies who remain charged with the political responsibility for the management of waste but for whom the shift towards a circular economy threatens to consign recently commissioned infrastructure, with a long design and operational life, to the scrap heap of history?

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DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are available in the supplementary material of this article.

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ENDNOTES

[1] Contracts in which street cleansing is part of an integrated waste management service are included.
[2] It also excludes in-house waste collection contracts, of which there are 203 in the larger dataset.
[3] The figure of 125 was not determined *a priori*. It is the point at which data saturation occurred in the documentary analysis, which was conducted concurrently with the archive generation. The documents consulted span the period from the late 1990s/early 2000s through to late 2019. They were supplemented with trade and industry reports and specialist media reporting. Further details of the archive are provided in Appendix S2.
[4] *Financial Times* – 9 January 2021; Barjot (2011) provides a useful historical contextualisation of the two firms.
[5] Following Juniper Consulting's (2005) review of MBT, in 2007 Defra highlighted the potential benefits to LAs procuring MBT solutions: increased recycling rates; reduced tonnage to landfill; the production of a compost-like output; the production of biogas and a refuse-derived fuel (Tolvik Consulting, 2017). This "soft" endorsement of the technology found further amplification from Friends of the Earth, one of the key NGOs opposing the widespread development of energy-from-waste in the UK.

[6] In support of this, in the mid-2000s Defra made £30m available through its New Technology Demonstrator Programme, to fund 10 demonstrator projects (Reno, 2011).

[7] The new entrants leading consortia bidding in the UK's waste market comprised major utilities firms (e.g., Viridor, United Utilities), established UK civil engineering firms (e.g., Balfour Beatty, Costain, Laing), and conglomerates (e.g., Interserve, Serco, Amey). They combined with a limited number of new firms (SMEs) Small and medium-sized enterprises specialising in new and emergent technologies in the sector. LAs procuring a non-energy-from-waste solution typically involved at least one major contract with such an SME (and further sub-contracts with its suppliers). The risk to the delivery of what, typically, was an integrated suite of technical plants therefore was considerable.

[8] The most optimistic of these claimed the potential to add over 20% to the level of recycling achieved through a municipality's "dry recyclable" collection (Tolvik Consulting, 2017). For those LAs seeking to be leaders in the field, this suggested that MBT would be key to achieving the recycling rates necessary to support those aspirations (>50%).

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix S1. Dataset summary.

Appendix S2. A Municipal Waste Archive.

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